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EVALUATION OF DISTRIBUTION FROM GRANULAR INSECTICIDE APPLICATORS

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EVALUATION OF DISTRIBUTION FROM GRANULAR INSECTICIDE APPLICATORS[1]

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SUMMARY

A study was made of the linear distribution of granules dispensed by pesticide application equipment. US 20/40-mesh attapulgite clay was used as a standard granule for most of the measurements, although a few trials were made with other granular materials. Weights of granules equivalent to distribution over 4-inch increments of travel at 4 miles per hour (m.p.h.) were taken. Feed rotors in the applicator hoppers were operated at speeds of 5 to 60 r.p.m. during the tests.

Distribution of granules from all applicators became more uniform as rotor speeds were increased to 20 r.p.m. Variation among samples from applicators with rotors with thin (1/32 inch) blades changed very little as the rotor speed was increased above 20 r.p.m. Variation among samples from the applicators with rotors with thick (1/8 inch) blades decreased constantly as the rotor speed was increased to 40 r.p.m. Variation among samples from the rotors with thin blades was always less than when the rotors with thick blades were used at the same rotor speed in the 5 to 40 r.p.m. range. The variation was lower among samples from the rotors with five blades than among similar rotors with more blades. Although the variation among samples dispensed by a pneumatic granular applicator was low, it was difficult to adjust the delivery rate over a practical range.

Ideally, the delivery rate should change by the same percentage as the percentage change in ground speed. The rotors with shallow blades (3/16 inch deep) delivered closer to the ideal rate than those with deeper blades. An experimental rotor with five blades, each 1/32 inch thick and 3/16 inch deep, produced little variation among samples dispensed in the 20 to 30 r.p.m. range. Delivery was close to the ideal rate as rotor speeds were increased to 30 r.p.m.

The amount of grinding of granular material dispensed by the applicators was investigated. The amount of ground material dispensed by one applicator that was constructed so that material is dispensed soon after it contacts the rotor was low.

INTRODUCTION

Granular insecticides are recommended to control certain soil-inhabiting insect pests. Because some of these insects move about very little, a uniform distribution of material is desirable for insect control with a minimum of insecticide. Application equipment must be capable of precise calibration and uniform application of the granular insecticide to obtain satisfacory control at minimum cost and to avoid accumulation of unnecessary residue.

Amounts of material dispensed from a granular applicator should change by the same percentage as any change in ground speed. An applicator whose feed rate does not change with ground speed will apply the correct dosage of insecticide only at calibrated speed. Granules should stop flowing when the machine is stopped and should start immediately when the machine starts.

Attrition of granules by the application equipment should be as little as possible. Pulverized material in the hoppers alters the feed rate and is susceptible to drift when applied under windy conditions, resulting in incorrect dosage and wasted material.

EXPERIMENTAL EQUIPMENT AND PROCEDURE

Equipment was constructed to determine the variation in distribution from granular insecticide applicators over 4-inch increments of travel. It consisted of a test stand to support the granular applicators and a turntable carrying 75 sample containers with 4-inch-square cross sections. (Figure 1 shows the test stand and turntable.) The turntable was driven by an electric motor. The center of the sample containers traveled at 4 m.p.h. when the samples were collected. The rotors of the granular applicators were driven by a variable speed belt drive from an electric motor. The applicators were mounted so that material was dispensed directly onto the center line of the sample containers during one revolution of the turntable.

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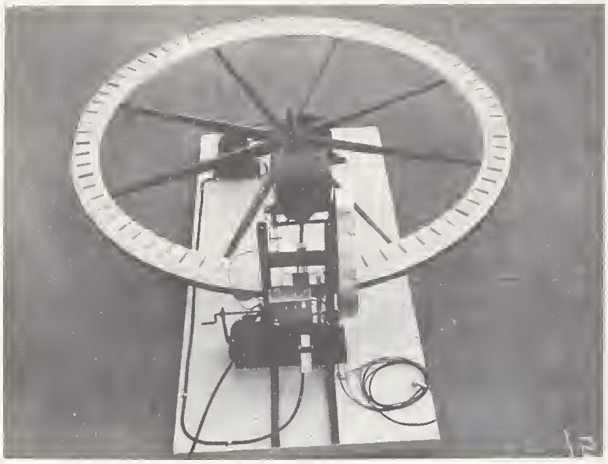

Figure 1.—Test stand and turntable used to sample distribution from granular insecticide applicators.

A chute actuated by a solenoid and spring controlled the flow of material into the containers. The solenoid was connected through a ratchet relay to a microswitch operated by a cam on the turntable. A holdswitch in the circuit allowed several revolutions of the turntable and granular applicator rotor before the solenoid pulled the chute to release granules into the sample containers. Material was collected in the sample containers during one revolution of the turntable. The mechanism then switched the flow of the material into a container beside the turntable.

Turntable and granular applicator rotor revolutions and 1-second time intervals were recorded on a strip chart. A pin on the applicator rotor shaft was fastened in an adjustable collar and set to operate a microswitch when a rotor blade was centered over the granular outlet. Information recorded on the strip chart was used to determine turntable and rotor speed. The sample container under the outlet when one of the blades was centered over the outlet could also be determined from the strip chart.

Five applicators were studied and various material and delivery rate combinations were used. Three of the applicators had rotors with blades; one was a belt feed type; and one was a pneumatic applicator. Experimental rotors were also constructed and used in commercial applicator boxes. In this publication, the complete applicator or its boxes will be designated A, B, and C. Standard rotors supplied with applicators A, B, and C will also be designated respectively A, B, and C. The experimental rotors will be designated 1, 2, 3, and 4.

Table 1 shows the applicator boxes, rotors, rotor speeds, and selected delivery rates of materials used to determine distribution variations. Three test runs were made for each combination shown in table 1. During each test run 75 samples were collected. Each applicator was set at a selected delivery rate before the first test run of each combination. This rate was determined by collecting the flow of granular material for 1 minute.

Variation in distribution from applicator A (fig. 2) and its own steel rotor A (fig. 3) was determined. Rotor B and experimental rotors 1, 2, 3, and 4 were also tried in applicator box A.

Figure 4 shows experimental rotor 1, and table 2 lists the dimensions of the commercial and experimental rotors. Rotors B and C had synthetic rubber blades. All other rotors used in this experiment had steel blades.

Variation in distribution from applicator B (fig. 5) with its own rotor B (fig. 6) and with experimental rotors was determined. Rotor B is made of a synthetic rubber material. The 10-blade rotor B was modified by removing five alternate blades for use in the box of applicator B. A rotor (Mod. A) similar to rotor A, with blade length reduced from 10 to 2 1/16 inches, was constructed and used in the box of applicator B.

Variation in distribution from applicator C (fig. 7) with its own rotor C was also determined. Rotor C is a synthetic rubber material with dimensions as shown in table 2. Figure 8 shows a top view of the metering compartment and baffle in applicator C.

The effect of rotor r.p.m. on the delivery rates of various granular applicator combinations was also measured. US 20/40-mesh Florex (AA-LVM) granules were used in all combinations. The orifice of the applicator was set to deliver the desired amount of material at a rotor speed of 15 r.p.m. When it was not possible to get the desired delivery rate, the orifice was set wide open. After the orifice was set, only the rotor speeds were changed. Granules delivered were collected during a 1-minute period at several rotor speeds from 5 to 60 r.p.m.

The amount of grinding of US 20/40-mesh Florex (AA-LVM) by granular insecticide applicators was investigated. The applicators were set to deliver about 35 grams per minute and operated for 30 minutes with the rotor turning at 20 r.p.m. Then a sample of the material being dispensed was taken for a 6-minute period. A sieve analysis of the sample indicated the amount of attrition.

Variation in distribution from a pneumatic applicator (fig. 9) was determined. This eight-outlet model conveys the granular material by air. Figure 10 shows the part used to mix air with the granules. The tube that extends halfway across the granule inlet opening is a modification to increase the granule discharge rate. Air enters the standard part through a 3/32-inch-diameter hole and the air mixed with the granules exits through a 7/32-inch-diameter hole. The inlet hole for the granules is 5/16 inch in diameter.

TABLE 1.–Applicator boxes, rotors, rotor speeds, and calibrated delivery rates of materials used to determine distribution variations

Applicator box and rotor	Rotor speed	Granular material	Delivery rate
Applicator Box A	*R.p.m*		*G. per min.*
Rotor A	5, 7, 10, 15, 20, 25, 30, 40	US 20/40 Florex[1]	232
Rotor A	20	Do.	116
Rotor A	20	Do.	35
Rotor A	20	US 20/40 chlordane 10 g.	232
Rotor A	20	US 20/40 corn cob meal	232
Rotor A	20	US 8/16 Florex[1]	232
Exp. rotor No. 4	20	US 20/40 Florex[1]	232
Exp. rotor No. 3	20	Do.	232
Exp. rotor No. 2	7, 20, 30	Do.	232
Exp. rotor No. 1	10, 15, 20, 25, 30	Do.	232
Exp. rotor No. 1	20	Do.	116
Exp. rotor No. 1	20	Do.	35
Exp. rotor No. 1	20	US 8/16 Florex[1]	232
Rotor B	20	US 20/40 Florex[1]	232
Applicator Box B			
Rotor B	5, 7, 10, 15, 20 25, 30, 40	US 20/40 Florex[1]	232
Rotor B	20	Do.	116
Rotor B	20	Do.	35
Rotor B	20	US 20/40 chlordane 10 g.	232
Rotor B	20	US 20/40 corn cob meal	232
Rotor B	20	US 8/16 Florex[1]	232
Rotor mod B	20	US 20/40 Florex[1]	232
Rotor mod A	20	Do.	232
Applicator Box C			
Rotor C	7, 15, 20, 30, 40	US 20/40 Florex[1]	232
Pneumatic			
No rotor		US 20/40 Florex[1]	160

[1] Trade name for attapulgite.

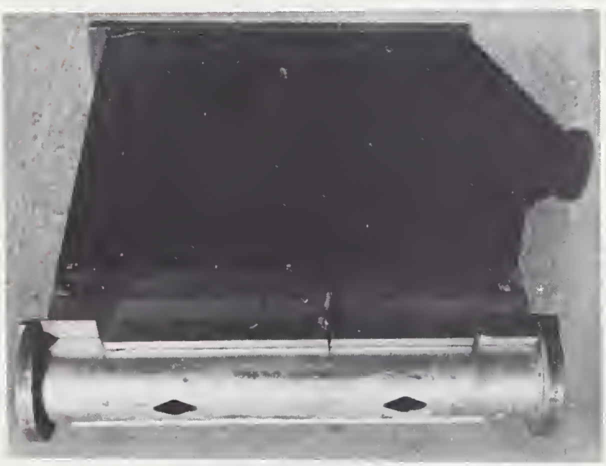

Figure 2.–Granular applicator A with metering rate slide removed.

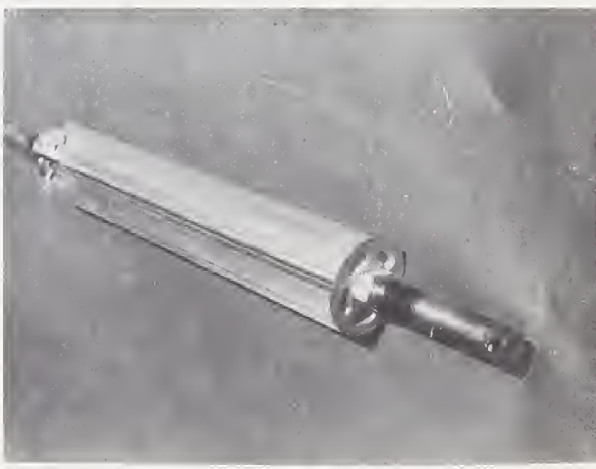

Figure 3.–Rotor A (standard rotor in applicator A).

Figure 4.–Experimental rotor number 1.

Figure 5.–Granular applicator B.

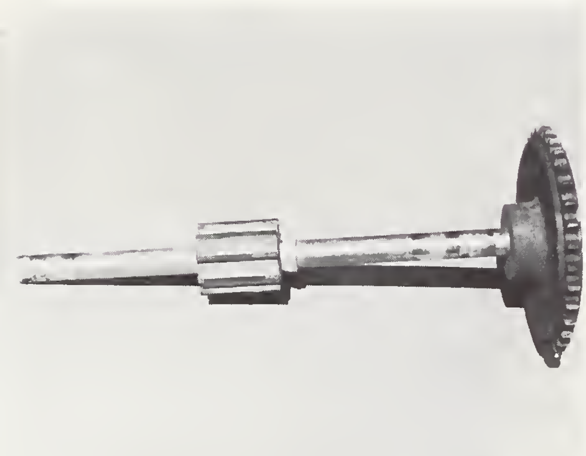

Figure 6.–Rotor B (standard in applicator B).

Figure 7.–Granular applicator C.

TABLE 2.–Specifications of rotors used in experiments

Rotor	Number of blades	Outside diameter	Size of blade, inches		
			Thickness at tip	Length	Depth
		Inches			
A	5	2	1/32	10	9/16
B	10	2	1/8	2 1/16	3/16
C	6	1 7/16	7/64	2 3/4	1/4
No. 1	5	2	1/32	2 1/2	3/16
No. 2	10	2	1/32	2 1/2	3/16
No. 3	5	2	1/32	2 1/2	13/32
No. 4	10	2	1/32	2 1/2	13/32
Mod. A	5	2	1/32	2 1/16	9/16

Figure 10.–Pneumatic applicator orifice with experimental tube inserted halfway across granule inlet.

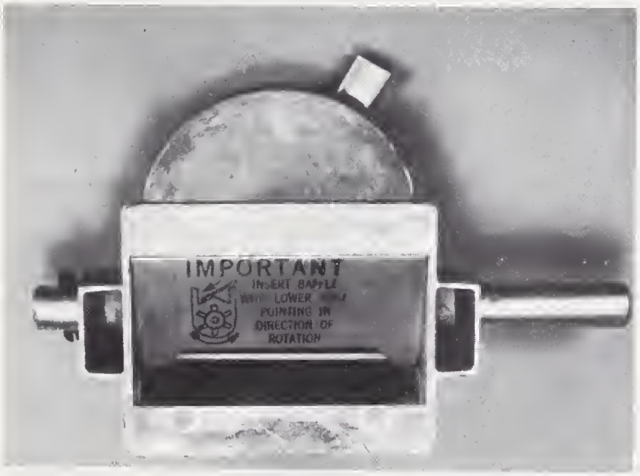

Figure 8.–Top view of metering compartment used with applicator C.

Figure 11.–Belt-feed granular applicator.

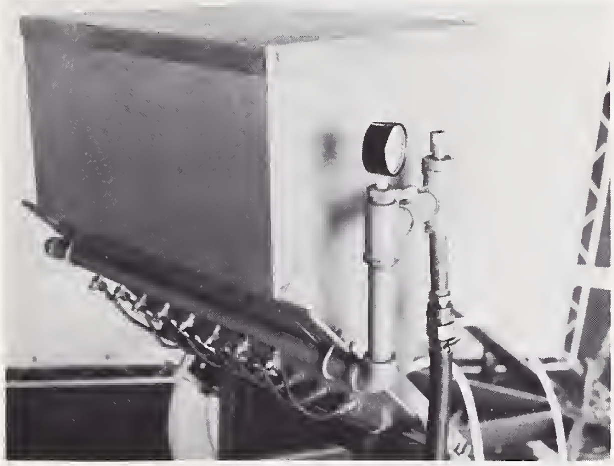

Figure 9.–A pneumatic granular applicator.

Factors affecting delivery rate from the pneumatic applicator were studied. The amount of delivery was determined when air pressure was adjusted over the 4 to 15 p.s.i.g. range, and 1/4- and 3/8-inch inside diameter (I.D.) outlet tubes from 28 inches to 24 feet long were used. Modifications of the air-granule mixing device were studied to increase delivery rate from the pneumatic applicator.

Granular distribution from a belt-feed applicator (fig. 11) for small plot work was measured. The synthetic rubber feed belt has a hollow "V" cross section about 1 5/8 inches wide and 1 5/16 inch deep. V-shaped cross ribs 3/32 inch thick and 1 inch wide are located 15/16 inch apart along the length of the belt. These ribs are 3/16 inch deep at the bottom of the V section. The applicator was mounted to distribute about 222 grams per minute

of US 20/40-mesh Florex into the sample containers on the turntable at a speed of 4 m.p.h. (Approximately 19 pounds per acre on a 38-inch row.)

Results and Discussion.

The mean, standard deviation and percent coefficient of variation (C.V.) of the samples were calculated for each test run. Each run consisted of 75 samples numbered consecutively from 1 through 75, and each sample represents the amount of material dispensed over a 4-inch increment of travel at 4 m.p.h. The variation among the 4-inch increments at 4 m.p.h. would also equal the variation among 5-inch increments at 5 m.p.h., or 6-inch increments at 6 m.p.h.

Figure 12 is a graph of the effect of rotor speed on the percent C.V. among samples. Each plotted point represents the mean of three test runs, or 225 samples. When possible, the applicators were set to deliver about 232 grams per minute, which at a ground speed of 4 m.p.h., is equivalent to 20 pounds per acre on rows 38 inches apart. In cases where some of the applicators would not deliver 232 grams per minute at low rotor speeds, the orifices were set wide open. Figure 12 shows that the percent C.V. of distribution from applicator A decreased rapidly as the rotor speed increased to about 15 r.p.m. Rotor speeds higher than 15 r.p.m. produced slightly more uniform distributions. The percent coefficients of variation of distribution from applicator B and C decreased continually as the rotor speed increased, but were always considerably more than the coefficient from applicator A at all rotor speeds used. Curves for applicators B and C have about the same slope, but the percent C.V. of distribution from applicator C is always less than from applicator B. The percent C.V. of distribution from applicators B and C approached that of applicator A as the rotor speed was increased. Rotor speeds of 40 r.p.m. may crush an excessive number of granules at low feed rates. At a rotor speed of 30 r.p.m., the percent coefficient of variation of distribution from applicators B, C, and A were, respectively, 23.48, 13.56, and 7.09. At rotor speeds between 20 and 30 r.p.m., the percent C.V. of distribution from applicator box A with experimental rotor number 1 was about the same as that of applicator A. Rotors with thin blades dispensed samples with the lowest percent coefficients of variation. The orifice area available for flow of granules is reduced by the area of the tip of the blade when the blade passes over the orifice.

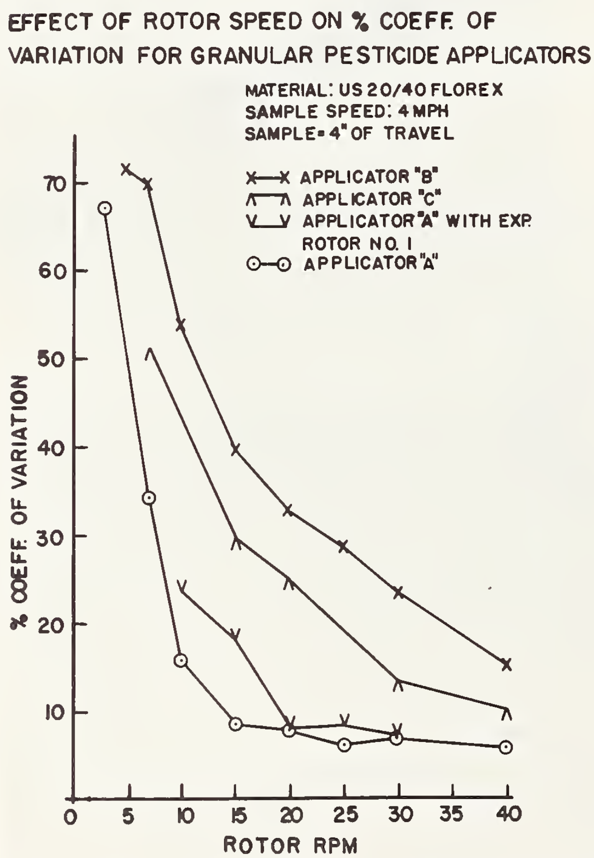

Figure 12.–Effect of rotor speed on percent coefficient of variations among samples distributed by pesticide applicators.

For every test run, graphs of grams per sample versus consecutive samples were plotted by a computer. Figures 13 through 22 show some of these graphs. The horizontal center line on the graphs is the mean sample weight.

Figure 13 shows the distribution of US 20/40-mesh Florex from applicator A when set to deliver about 232 grams per minute at a rotor speed of 7 r.p.m. The mean sample weight was 0.220 grams. Consecutive sample numbers 17 through 28 (48 inches of travel) and 48 through 59 (44 inches of travel) each contained less than 75 percent of the mean sample weight. Consecutive sample numbers 2 through 9 (32 inches of travel), 30 through 40 (44 inches of travel), and 61 through 70 (40 inches of travel) each contained more than 125 percent of the mean sample weight. Only 92 inches, or 30 percent of the row, received within 25 percent of the calibrated delivery rate. The sample weights ranged from 0.090 to 0.342 grams, or from 39 to 141 percent of the calibrated delivery rate. If the ground speed were increased to 6 m.p.h. and the rotor operated at 7 r.p.m., the lengths of row receiving less than 75 and more than 125 percent of the mean delivery rate would be increased 50 percent.

Figure 14 shows the distribution of US 20/40-mesh Florex from applicator A set to deliver about 232 grams

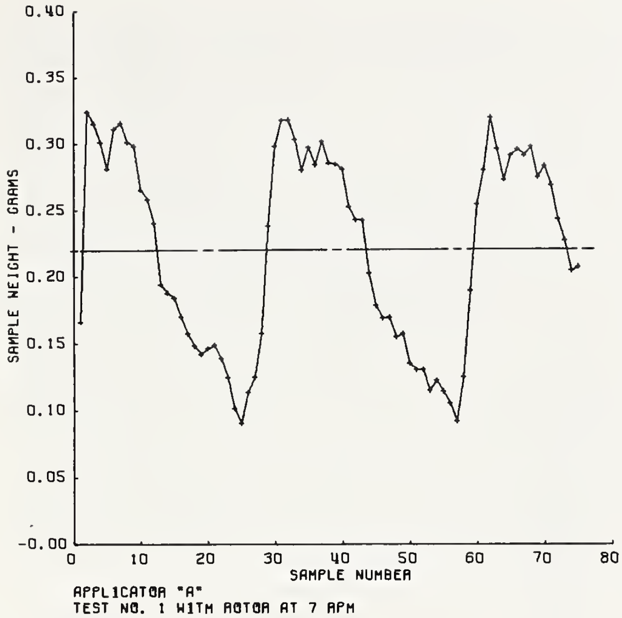

Figure 13.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

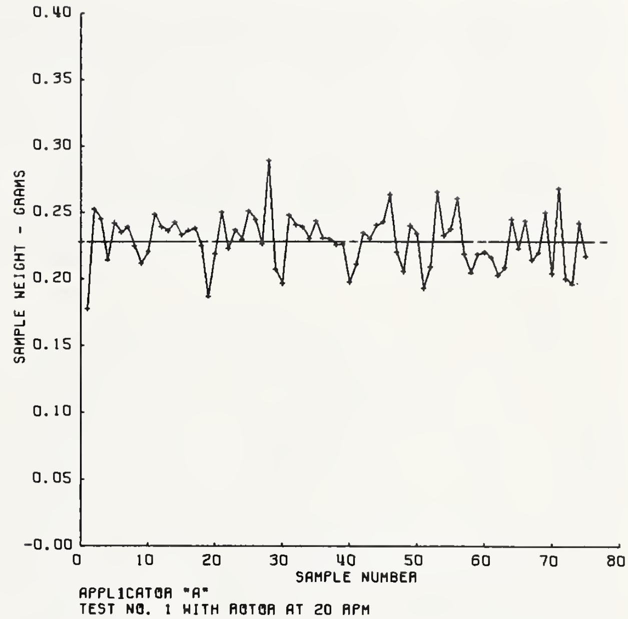

Figure 14.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

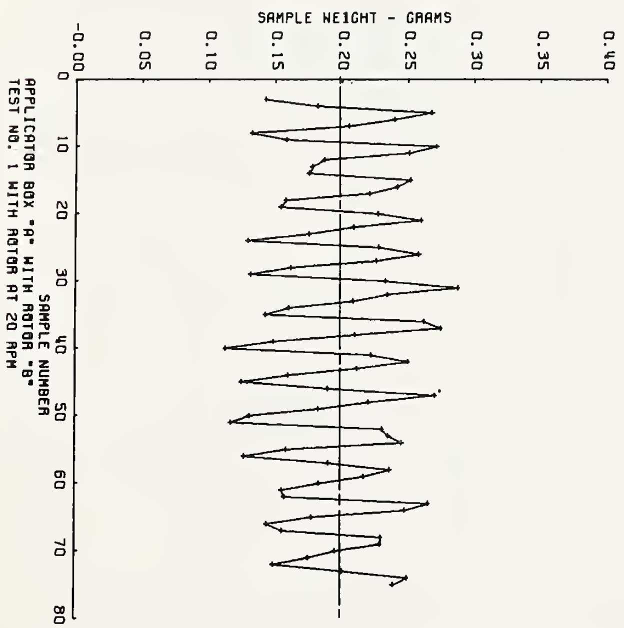

Figure 15.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

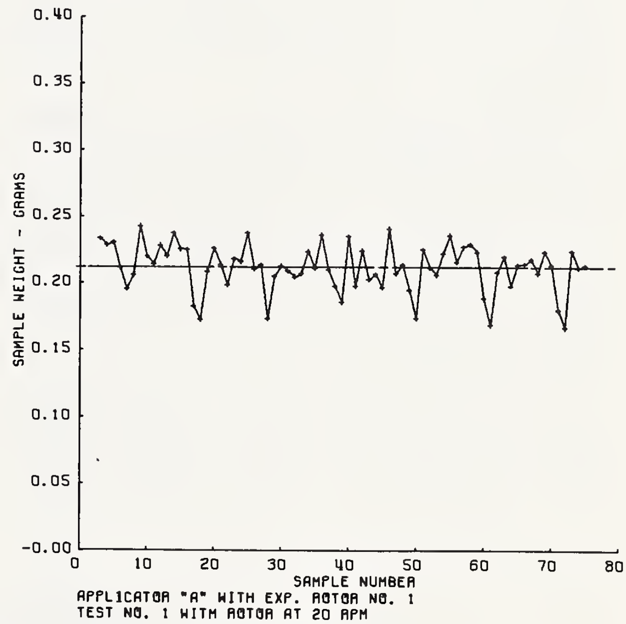

Figure 16.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

per minute with rotor speed increase to 20 r.p.m. The variation is considerably more when the rotor is operated at 7 r.p.m. All of the sample containers received within 25 percent of the calibrated delivery rate.

Figure 15 shows the distribution of US 20/40-mesh Florex from applicator A with rotor B at 20 r.p.m. A calibrated rate of 232 grams per minute (0.22 grams per sample) was attempted, but when it was not possible, the orifice was set wide open. The mean sample weight was 0.199 grams. Twelve samples (16 percent of the samples) each contained less than 75 percent of the mean sample weight. Each of twelve of the samples also

contained more than 125 percent of the mean sample weight. Only 68 percent of the length of the row received within 25 percent of the mean delivery rate. When applicator box A with rotor A at 20 r.p.m. was set to deliver about 232 grams per minute, 100 percent of the length of the row received within 25 percent of the mean delivery rate. Variation in delivery from rotor A is probably less than from rotor B because rotor A has fewer blades and they are only about one-fourth as thick as those of rotor B.

Figures 16 and 17 show the distribution of US 20/40-mesh Florex from applicator box A with experimental rotors. The delivery rate was set at about 232 grams per minute when the rotors were run at 20 r.p.m. Figure 16 shows the distribution from experimental rotor number 1. Figure 17 and table 3 show the distribution from rotor number 2. The rotors are similar, but number 1 has five blades and number 2 has 10. All of the samples in figure 16 received within 25 percent of the calibrated delivery rate. In figure 17, 14 samples (or 19 percent) each contained less than 75 percent of the mean sample weight; and 33 samples (or 44 percent) each contained more than 125 percent of the mean sample weight. The variation in distribution from the five-blade rotor was much less than when the 10-blade rotor was used.

Figure 18 shows the distribution of US 20/40-mesh Florex from applicator B when set to deliver about 232 grams per minute at a rotor speed of 25 r.p.m. Twenty-two samples, or 29 percent, each contained less than 75 percent of the mean delivery rate; and 18 samples, or 24 percent each contained more than 125 percent of the mean delivery rate. Only 35 samples, or 47 percent of the row, received within 25 percent of the calibrated delivery rate.

Figure 19 shows the distribution of US 20/40-mesh Florex from applicator box A with modified rotor B. Five alternate blades were removed from the manufacturer's 10-blade rotor B. The delivery rate was set at about 232 grams per minute at a rotor speed of 20 r.p.m. Thirteen samples, or 17 percent, each contained less than 75 percent of the mean sample weight; and three samples, or 4 percent of the samples, each contained more than 125 percent of the mean sample weight. Fifty-nine samples, or 79 percent of the row, received within 25 percent of the calibrated delivery rate. The variation in distribution from applicator B decreased considerably when five blades were removed from the standard 10-blade rotor. When the standard rotor was used under identical conditions, only 47 percent of the row received within 25 percent of the calibrated delivery rate. The percent C.V. among samples from the 10-blade rotor was 32.69. The percent C.V. among samples from the five-blade rotor was 22.69.

Figure 20 shows the distribution of US 20/40-mesh Florex from applicator B with a rotor similar to rotor A.

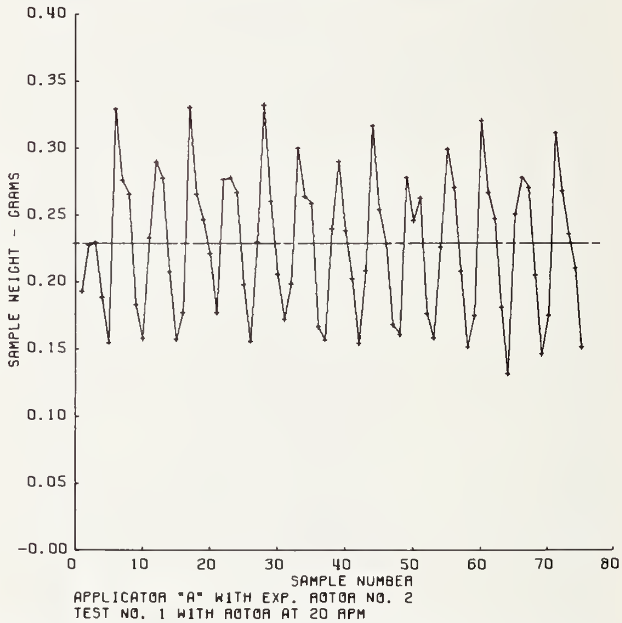

Figure 17.—Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

TABLE 3.—Distribution of US 20/40-mesh Florex from pesticide applicator A with rotor number 2[1]

Turn-table (r.p.m.)	Sample speed	Rotor speed	Orifice setting	Mean sample weight	Standard deviation	Percent coefficient of variation
	M.p.h.	*R.p.m.*		*Grams*		
14.20	4.04	6.98	[2] 80	0.08407	0.03830	45.23
14.13	4.02	19.70	80	.22530	.05055	22.43
14.18	4.03	29.99	46	.20963	.02128	10.15

[1] See table 2 for rotor dimensions.
[2] When the calibrated rate of 232 grams per min. (0.22 grams per sample) that was attempted was not possible, the orifice was set wide open.

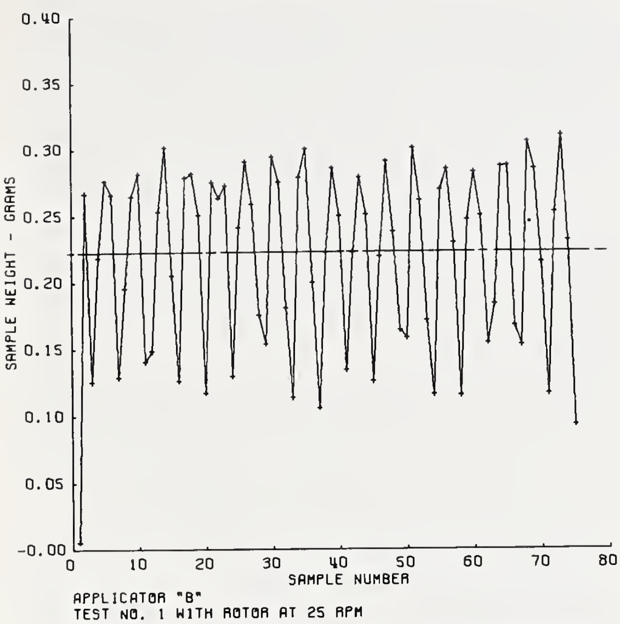

Figure 18.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

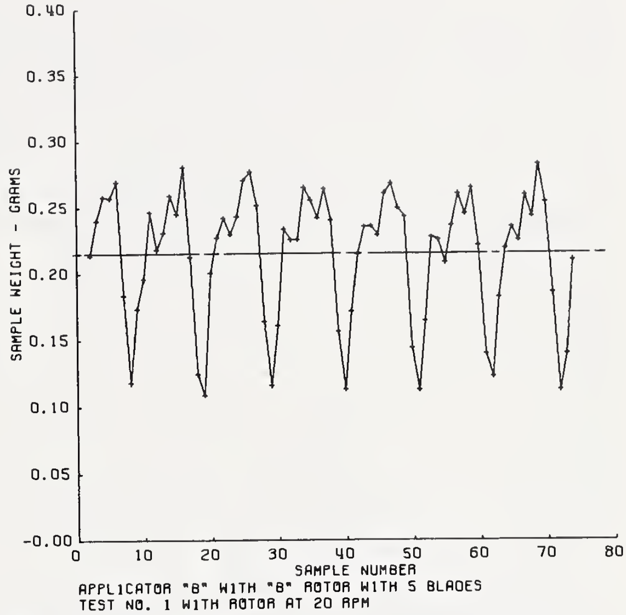

Figure 19.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

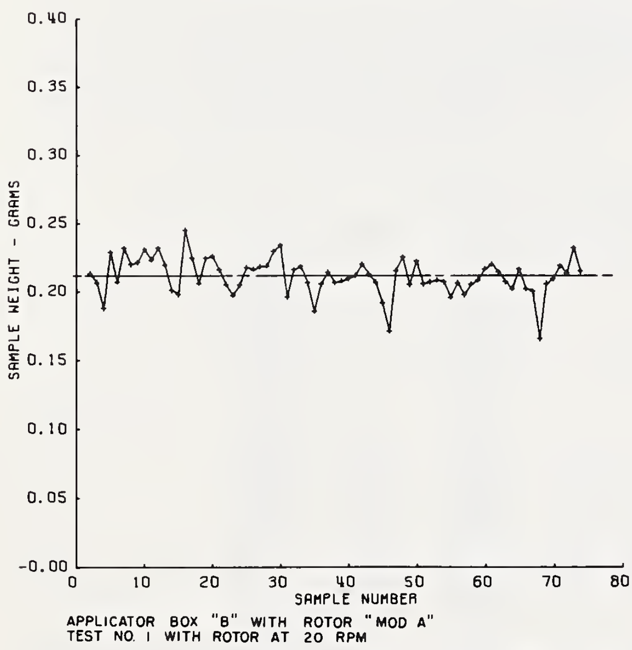

Figure 20.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel down the row using a short blade modification of rotor A (30 samples = 10 feet).

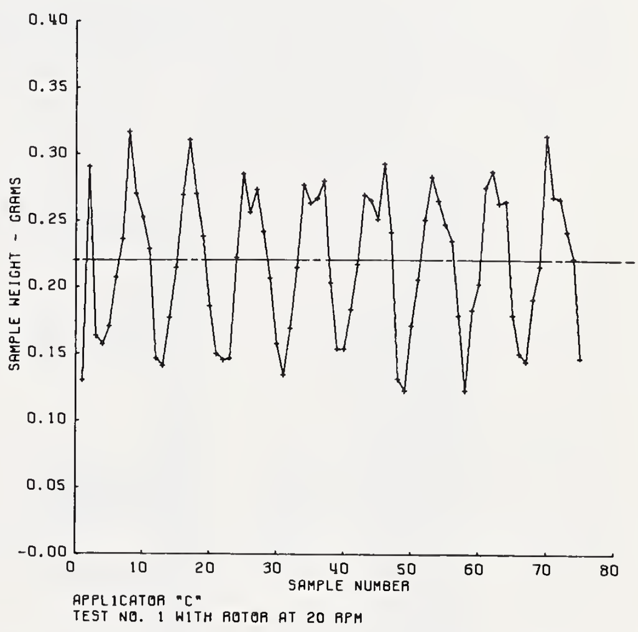

Figure 21.–Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

The dimensions of the rotor (Mod. A) are similar to those of rotor A, but the blade length was 2 1/16 inches instead of 10 inches. The applicator was set to deliver about 232 grams per minute at a rotor speed of 20 r.p.m. All of the samples in figure 20 were within 25 percent of the calibrated delivery rate. There was a mean percent C.V. of 6.36 among the sample weights for the three test runs.

Figures 21 and 22 show the distribution of US 20/40-mesh Florex from applicator C when set to deliver about 232 grams per minute. Figure 21 shows the distribution when the rotor operated at 20 r.p.m.

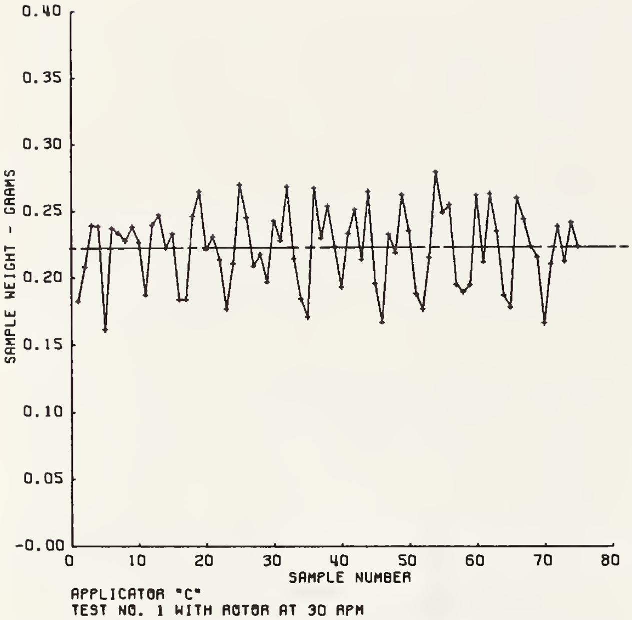

Figure 22.—Variation in flow rate of US 20/40-mesh Florex granules with applicator travel.

Fourteen samples (19 percent) each contained less than 75 percent of the mean delivery rate; and 28 samples (37 percent) each contained more than 125 percent of the mean delivery rate. Only 33 samples, or 44 percent of the row, received within 25 percent of the calibrated delivery rate. Figure 22 shows the distribution when the rotor turned at 30 r.p.m. Three samples (4 percent) contained less than 75 percent of the mean delivery rate; and only one sample contained more than 125 percent of the mean delivery rate. Seventy-one samples, or 95 percent of the row, received within 25 percent of the calibrated delivery rate.

Three test runs to collect granular distribution samples on the turntable were made for various combinations of pesticide boxes, materials, delivery rates, and rotors at 20 r.p.m. Table 4 shows the mean percent C.V. of the three test runs for the various combinations.

Table 4 shows that the percent C.V. of distribution of US 20/40-mesh Florex from applicator A was about the same (8 percent) when the delivery rate was either 232 or 116 grams per minute. It increased to 11.91 percent when the delivery rate was 35 grams per minute. The

TABLE 4.—Percent C.V. among samples for various granular applicator boxes, granules, delivery rates, and rotors operated at 20 r.p.m.

Applicator box and rotor[1]	Material	Calibrated delivery rate	Percent C.V.
Applicator Box A		*G. per min.*	
Rotor A	US 20/40 chlordane 10 g.	232	7.46
Exp. rotor No. 3	US 20/40 Florex	232	7.48
Rotor A	Do.	232	7.95
Rotor A	Do.	116	7.98
Exp. rotor No. 1	Do.	232	8.25
Rotor A	US 20/40 corn cob meal	232	8.38
Exp. rotor No. 4	US 20/40 Florex	232	9.26
Exp. rotor No. 1	Do.	116	9.65
Rotor A	Do.	35	11.91
Exp. rotor No. 1	Do.	35	15.01
Rotor B	Do.	([2])	20.08
Exp. rotor No. 1	US 8/16 Florex	([2])	20.68
Exp. rotor No. 2	US 20/40 Florex	232	22.43
Rotor A	US 8/16 Florex	232	22.80
Applicator Box B			
Rotor mod A	US 20/40 Florex	232	6.36
Rotor B	Do.	35	14.92
Rotor B	Do.	116	19.19
Rotor B with 5 blades	Do.	232	22.69
Rotor B	US 20/40 chlordane 10 g.	232	28.85
Rotor B	US 20/40 Florex	232	32.69
Rotor B	US 20/40 corn cob meal	232	38.54
Rotor B	US 8/16 Florex	232	47.23
Applicator Box C			
Rotor C	US 20/40 Florex	232	25.03

[1] See table 2 for dimensions of rotors.

[2] When the calibrated delivery rate of 232 grams per minute that was attempted was not possible, the orifice was set wide open.

percent C.V. of distribution from applicator B decreased as the delivery rate decreased. At delivery rates of 232, 116, and 35 grams per minute, the percent coefficients of variation were 32.69, 19.19, and 14.92, respectively. The variation in distribution from applicator A with rotor 1 was about the same as the variation in distributions from applicator A when it was set to deliver 232, 116, and 35 grams per minute.

Table 4 also shows that the percent coefficients of variation of distribution of US 20/40-mesh chlordane-10 g. from applicators A and B were about the same as when US 20/40-mesh Florex was used. Applicator A also distributed US 20/40-mesh corn cob meal with about the same variation as US 20/40-mesh Florex. Applicator B did not distribute corn cob meal as uniformly as it distributed Florex.

Neither applicator B nor A, nor applicator box A with rotor 1 distributed US 8/16-mesh Florex as uniformly as they did US 20/40-mesh Florex. The percent C.V. in distribution of US 8/16-mesh Florex form applicator B was 47.23.

From the strip charts, it was possible to determine which sample container was under the outlet when the rotor blade was centered over the outlet. An analysis of several recordings indicated that the sample weight was low when a blade was centered over the outlet. When a blade is over the outlet, the area available for flow is reduced by the area the blade tip covers.

The effect of rotor speed on delivery rate from the granular applicators with rotor was studied. When granular pesticide applicators are mounted on a planter, the rotor is usually chain-driven from the press wheel. Thus, rotor speed is directly related to ground speed. Ideally, the delivery rate should change by the same percentage as any percentage change in ground speed. Table 5 and figure 23 show the results of the study.

Figure 23 shows the effects of rotor speed on the delivery rates of applicators A, B, and C, and also shows an ideal delivery rate line. The applicators were set to deliver 232 grams per minute when the rotor speed was 15 r.p.m. The delivery rate from applicator A increased rapidly as the rotor speed increased to 10 r.p.m., and then decreased slightly as the rotor speed increased to 60 r.p.m. The delivery rate from applicator B increased constantly as the rotor speed increased, and was close to the ideal delivery rate at rotor speed up to about 30 r.p.m. The delivery rate from applicator C increased as the rotor speed increased, but at rotor speeds above 20 r.p.m., the delivery rate dropped considerably below the ideal rate.

The effect of rotor speed on the delivery rates of experimental rotors 1, 2, 3, and 4 in applicator box A was also investigated. Rotor 2 delivered only 195 grams per minute when the orifice was set wide open at a rotor speed of 15 r.p.m. Rotors 1, 3, and 4 were also set to deliver about 195 grams per minute at a rotor speed of

TABLE 5.–Effect of rotor r.p.m. on delivery rate (grams per minute) of US 20/40-Florex from various granular pesticide boxes and rotors

Rotor[1]	Orifice setting	Rotor r.p.m.									
		5	10	15	20	25	30	35	40	50	60
Applicator box A:											
A	43	164.7	258.6	253.4	247.1	245.6	232.7	241.1	237.0	239.0	246.2
A	30	125.9	110.3	107.8	104.9	--	106.6	--	113.0	117.6	124.4
B	[2] 80	62.0	120.0	174.8	216.2	260.0	288.6	337.4	375.0	435.6	486.0
A	35½	156.0	135.2	174.6	164.0	162.4	163.0	165.4	169.0	180.0	184.0
No. 1	62	72.0	138.0	196.0	246.0	298.0	342.0	385.0	428.0	495.0	534.0
No. 2	[2] 80	75.0	130.7	195.0	248.0	296.6	352.6	398.6	436.8	--	585.6
No. 3	37	126.8	206.0	195.0	184.0	183.7	184.4	185.6	189.0	195.0	201.0
No. 4	42	94.0	162.0	195.0	195.0	191.0	190.0	192.0	189.0	192.0	191.0
Applicator box B:											
B	3-28	83.4	162.2	232.3	295.9	357.6	410.5	464.2	511.9	588.0	630.9
Mod. B[1]	3-15	87.0	166.4	232.0	296.8	358.0	402.0	444.0	486.0	510.0	516.0
Mod. A[3]	2-28	157.6	244.2	236.0	229.0	220.0	224.0	220.0	220.0	224.4	227.2
B	3-13	68.5	132.7	174.4	233.0	276.0	319.0	343.0	367.0	391.5	388.5
Applicator box C:											
C	46	98.5	176.9	241.2	291.4	329.4	356.2	377.2	384.0	397.8	402.0

[1] Rotors A, No. 1, and No. 3 have 5 blades. Mod. B was a 10-blade B rotor with 5 alternate blades removed.
[2] Feed orifice wide open.
[3] Same as rotor A except the blades are each 2 1/16 inches long (see table 2).

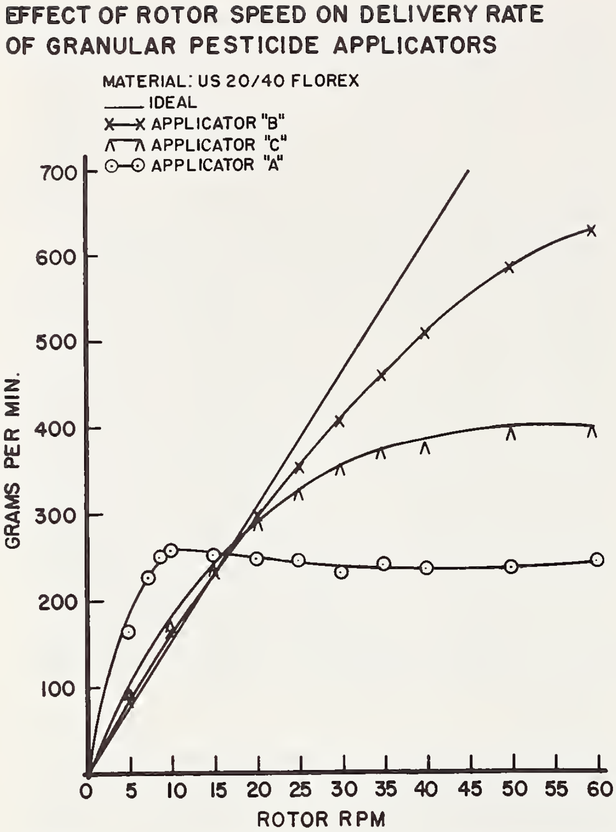

Figure 23.—The effect of rotor speed on delivery rates from applicators A, B, and C.

15 r.p.m. The delivery rates from rotors 1 and 2 increased constantly as the rotor speeds increased, and were close to the ideal rate up to about 30 r.p.m. The curves of delivery rate at various rotor speeds from rotors 3 and 4 were similar to the curve of applicator A shown in figure 23. The delivery rates from rotors with shallow blades remained closer to the ideal rate over a greater range of rotor speeds than did the delivery rates from those with deep blades.

Five alternate blades were removed from rotor B and the effect of rotor speed on delivery rate was investigated. The delivery after recalibration was almost the same as that from standard rotor B at rotor speeds up to 35 r.p.m. There was little difference between similar 5- and 10-blade rotors when the effect of rotor speed on delivery rate was investigated. In table 5, rotor 1 can be compared with rotor 2 and rotor 3 can be compared with rotor 4, because their dimensions are similar except for number of blades. In each case, the five-blade rotors required a smaller orifice setting than the similar 10-blade rotor to obtain the same delivery rate.

The effect of rotor speed on the delivery rates of a rotor similar to rotor A (Mod. A) in applicator box B and of rotor B in applicator box A was investigated. The data from the rotor Mod. A in applicator box B produced a curve similar to applicator A shown in Figure 23. The data from rotor B in applicator box A produced a curve similar to the curve for applicator B shown in figure 23.

The amount of grinding of US 20/40-mesh Florex by granular insecticide applicators was investigated. Amounts of material retained on the US 40-mesh sieve of samples dispensed from applicators C, B, and A were 93.4, 89.8, and 87.3 percent, respectively. Applicator C probably ground less material because of its construction. Rotor C is short and in a small compartment under the main hopper, and there is a baffle to direct the material to the discharge side of the rotor. All of the material on the rotor is discharged soon after contact. Rotor A is located in the main hopper and runs the full length of the hopper. Material could be in contact with the rotor for a long time before it is discharged.

Factors affecting the flow rate from a pneumatic applicator were studied. There was little variation in distribution of US 20/40-mesh Florex granules collected from the applicator. This applicator was operated with manifold air pressure at 10 p.s.i.g. Averages for four trials were as follows:

Mean sample weight, g.	0.153
Standard deviation	.0105
Percent coefficient of variation	6.88

Table 6 shows the delivery rate from the pneumatic applicator for various outlet tubes, manifold, pressures, and orifice modifications. The inside diameter of the tube has considerable influence on the delivery rate. The delivery rate from the 1/4-inch I.D. tube, 91 inches long (combination No. 2) was always considerably less than that from a 3/8-inch I.D. tube, 91 inches long (combination No. 6). The length of the tube also influences the delivery rate. The delivery rate from the 3/8-inch I.D. tube, 24 feet long (combination No. 3) was always considerably less than that from the 3/8-inch I.D. tube, 91 inches long (combination No. 6). Various bend radii in the outlet tube also influenced the delivery rate (table 6). Refer to data in table 7 for this information.

The delivery rate from the pneumatic applicator increased considerably when the air jet-granular inlet relation was modified. Figure 10 shows the original granule inlet orifice with a copper tube extended 5/32 inch, or halfway, across the granule inlet opening. The added tube was 5/8 inch long with an inside diameter of 1/16 inch. Table 8 shows the effect on delivery rate of extending the jet tube various distances across the granule inlet. The delivery rate was greatest when the jet tube extended 5/32 inch, or halfway across the granule inlet. Table 6 also shows the effect of the jet tube. The delivery rate from combination No. 4 (with jet tube) was

TABLE 6.–Delivery rate of US 20/40 Florex (grams per 30 seconds) from pneumatic applicator for various outlet tubes, manifold air pressures, and orifice modifications

Manifold air pressure (p.s.i.g.)	Combination No.[1]						
	1	2	3	4	5	6	7
1	31.0	17.0	--	--	--	--	--
2	41.4	17.3	23.1	--	--	55.0	--
3	44.8	18.0	--	--	--	--	--
4	57.8	19.3	44.0	--	113.4	84.8	33.6
5	62.2	20.6	--	86.9	132.9	--	41.0
6	66.2	22.3	57.2	101.5	144.3	108.9	46.8
7	72.2	24.1	--	117.9	158.4	--	53.0
8	82.4	24.9	71.0	130.0	170.4	132.2	58.3
9	81.5	26.3	--	141.0	180.3	--	61.7
10	88.5	28.0	85.5	154.5	191.9	155.8	66.0
12	92.5	--	--	--	--	--	--
15	103.0	36.2	--	--	--	--	80.7

[1] Combination No. 1: 1/4-inch I.D. tube x 28 inches long and vertical.
Combination No. 2: 1/4-inch I.D. x 91 inches long and horizontal.
Combination No. 3: 3/8-inch I.D. x 24 feet long and horizontal.
Combination No. 4: 3/8-inch I.D. x 24 feet long and horizontal. Copper tube (1/16 inch I.D. x 5/8 inch long) extended 5/32 inch across granule inlet opening.
Combination No. 5: 3/8-inch I.D. tube x 91 inches long and horizontal. Copper tube (1/16 inch I.D. x 5/8 inch long) extended 5/32 inch across granule inlet opening.
Combination No. 6: 3/8-inch I.D. tube x 91 inches long and horizontal.
Combination No. 7: 1/4-inch I.D. tube x 91 inches long and horizontal. Copper tube (1/16 inch I.D. x 5/8 inch long) extended 5/32 inch across granule inlet opening.

TABLE 7.–Delivery rate of US 20/40-mesh Florex from pneumatic applicator for various bend radii of the outlet tube

[Manifold air pressure: 6 p.s.i.g. Outlet tube: 3/8 inch inside diameter, 91 inches long]

Outlet tube condition	Delivery rate
	Grams per 30 seconds
Straight and horizontal	112.2
1 horizontal 20-inch-diameter coil	95.8
2 horizontal 10-inch-diameter coils	89.5
4 horizontal 5-inch-diameter coils	72.5

much greater than that from combination No. 3 (without jet tube). The delivery rate from combination No. 5 (with jet tube) was much greater than that from combination No. 6 (without jet tube).

Samples of distribution taken from the belt-type applicator indicated that granular distribution varied considerably down the row. The appearance of a cross rib on the belt at the point of discharge resulted in samples with weights considerably below the mean delivery rate. The distribution down the row varied more than the distribution from the rotors with five 1/32-inch-thick blades when the rotors were operated at 20 r.p.m.

TABLE 8.–Delivery rate of US 20/40-mesh Florex from pneumatic applicator for various positions of jet tube inserted in granule inlet

[Air pressure: 10 p.s.i.g. Outlet tube: 3/8 inch I.D., 91 inches long, and horizontal

Jet tube[1] position	Delivery rates
Inches[2]	*Grams per 30 seconds*
0	157.4
0.078	184.0
0.156	189.6
0.234	147.8
0.313	0

[1] Jet tube dimensions: 3/32 inch O.D., 1/16 inch I.D., 5/8 inch long.
[2] Extended across 5/16-inch diameter of granule inlet.

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